

On-line Naval Engineering skills supplemental training program

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Abstract: This paper proposes development of an e-learning and knowledge management training program designed to assist naval engineers with the transition between academic course work and applications unique to the experiences of naval and marine design engineers. The model for this program is a technology-focused version of the program currently employed by the Defense Acquisition University (DAU). DAU has demonstrated that a structured e-learning training program and specialized knowledge management tool can be a cost effective means to provide large groups of government employees specialized training on complex subjects. Creating a series of on-line training modules for a Naval engineering and marine engineering oriented curriculum and supporting it with a knowledge management system that parallels the current DAU Acquisition training method is a logical extension of this success. Such a program would directly benefit the general level of effectiveness of all civilian engineers, but would be particularly useful in engineering roles where breadth of general knowledge can influence the quality of a specific engineering product, such as the role of a design engineer. The proposed program is to be used in parallel with existing training programs, on-the-job training and specialized training programs, with an emphasis on core competency skill development and inter-relationships between systems. Such a program would serve as a flexible tool for supervisors, be familiar to new engineers, and provide Human Resources (HR) organizations a snapshot of subject specific intellectual assets at any time. A training tool of this type would provide employees a life-long engineering knowledge management software toolbox that could be centrally updated and maintained by the appropriate Naval technical authority.

Introduction

“People are our Greatest Strength” –NSWC CD CCD Mission/Vision Guiding Principle

“Strive to attract, recruit, develop and retain a high-performing competency based and mission focused workforce” –NAVSEA Goal

“Through our communications, education, policies, programs and conduct, each of us must actively foster environments where people are valued, respected and provided the opportunity to reach their full personal and professional potential” –CNO Guidance

“To keep America competitive, one commitment is necessary above all: We must lead the world in human talent and creativity. Our greatest advantage has always been our educated, hardworking ambitious people” –President George W. Bush, State of Union Address Feb 2006.

As these quotes suggest, the need to attract, develop, and maintain a leading-edge engineering workforce in the government is a well-defined U.S. Navy objective. Existing naval civilian engineering workforce development programs currently employ a wide variety of learning techniques and opportunities to help new engineers and scientists make the transition from the classroom to the workplace and quickly contribute to the constant state of readiness necessary for an organization to perform its mission. This paper focuses on providing a learning tool for predominantly non-academic subjects that represent directly applicable naval and marine

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engineering knowledge needed for success in civilian engineering roles where an overarching understanding of the interrelationships between marine engineering systems, systems of systems, and the interfaces are required. The premise is to provide training for these areas in a series of e-learning modules that are supplemented by classroom support and on the job training in a manner similar to that used by the DAU. The specific engineering role used as an example throughout this paper is that of a naval design engineer, although there are arguably many other roles with similar needs. The breadth of information required to make good design related decisions in many other government engineering roles also demands an overall understanding of complex equipment, systems, and systems of systems in order to make good decisions about some small part of the larger entity. Most importantly, a capacity to balance customer needs with sound engineering judgment in most naval engineering design related roles begins with a general understanding about operations, systems design, life-cycle logistics, and manufacturing processes and follows with a more comprehensive understanding about the specific components or systems being designed. Thus, there is a substantial group of potential beneficiaries for a program delivering, maintaining and preserving this type of knowledge.

Systems engineer is another role that demands large amounts of overarching and interface knowledge and one that has a successful example of both training and knowledge management within the government. Systems engineering has even been defined as the design of equipment or systems of equipment that are too complex for any one person to encompass all the details (Noe, 1962). Within the government community, the DAU has more recently provided a definition for systems engineers as those who focus on the technical effort to evolve and verify an integrated and total life-cycle balanced set of system, people, and process solutions that satisfy customer needs. DAU has been involved in the training of systems engineers engaged in the defense acquisition process for many years using the Acquisition, Technology, and Logistics Performance Learning Model (PLM) as the method to achieve success. This model includes knowledge sharing, classroom and on-line training classes, performance support, and a continuous learning program (DAU, AT&L PLM).

The purpose of this paper is twofold. First, the paper proposes a technical e-learning training model that delivers improved naval engineering design capability and understanding using an e-learning and knowledge management tool similar to the DAU PLM system. Second, the paper suggests that these e-learning modules be eventually organized in a “Defense Technical University” system that parallels that employed by the DAU for acquisition programs. Such a program will offer engineering supervisors an additional cost-effective tool and help the Navy achieve the objective of maintaining a continually well-trained engineering design workforce.

The first step towards adapting the DAU PLM model to the role of the naval design engineer is to look at the raw material associated with the engineering work force, the government engineers. This will be achieved through review of government engineer demographics and characteristics. We will then look at existing processes for forming this raw material into a desired shape through review of some of the training methods for transitioning new engineers from academia to a role in the government and discuss the advantages and disadvantages of each method. We will then see what is required to further take this material and forge and shape it into a design engineer by becoming a bit more focused on the unique training

needs involved in the design engineering role. At this point, we will propose how a PLM tool might augment the design engineer crafting processes, specifically, use of an e-learning tool and knowledge management system to supplement other forms of training. We will justify how this tool is particularly well suited to the training needs of engineers in the role of the design engineers. To illustrate the potential effectiveness of this process, we will look briefly at some of the characteristics of good naval design engineers and discuss how the new training tool could provide both a rapid transition from academia and career life-cycle training support. Finally, the paper will discuss how collective application of the new process could lead to a better-rounded design engineering workforce with a synergistic strength in core competencies capable of providing our nation the engineering edge required for continued naval engineering leadership.

DAU Performance Learning Model

The DAU PLM model uses several training techniques to get acquisition workforce members trained in complex subjects such as systems engineering. One technique involves providing training in a progressively structured learning experience with stratified requirements that correspond to Defense Acquisition Workforce certification levels. This enables control of subject matter learning rate and provides intermediate verification that subject material is understood through quiz score feedback. Further, it shows students there is a well-defined list of requirements to achieve the objective certification level, similar to an academic degree or Scout rank. Selected subjects and requirements for levels are determined by role in the acquisition process (program manager, contracts specialist, systems engineer, etc.) and progressive with the level of experience. The certification level desired for various positions within a Command is typically part of a position description for workforce members. Another observation about the DAU PLM program is the existence of an active knowledge-sharing tool through on-line access to regulations and tools, on-line collaborative communities, and a virtual library of material. One on-line tool is the “Ask a Professor” feature, where access to a subject matter expert can provide additional insight on specific topics, and searchable blogs containing other questions perhaps initially not considered can be reviewed for further understanding. A third observation about this program is the efficient use of instructor time. Students are typically given extensive on-line self-paced coursework to complete before being allowed to sit in a classroom with an instructor, and they must achieve a certain level of competence before being allowed to continue in the program. This allows the instructor to move quickly and include interactive simulations where course material is directly applied in simulation exercises for greater understanding. The prerequisite also narrows the potential student population to just those motivated enough to complete the required classes. The fourth and final observation about this program is that a course material virtual toolbox is built from each new e-lesson training course, continuous learning module and electronic resource provided during training. The subject matter in this virtual toolbox is maintained by DAU with updates and additions to represent accurate information at the time students access it. Since the breadth of material a student is exposed to during DAU training is quite large, it is unlikely a student will get a chance to use all materials during an actual job experience. Naturally, portions of the material presented may be forgotten over time. The virtual toolbox acts like a silent collaborator and allows the student to refresh his memory, thus empowering him to solve his own problems before asking a professor or a supervisor for information. In short, the knowledge management portion of the DAU leaves the student with the

confidence that even after a period of inactivity between initial exposure and need on the job, he could easily review learned material and find the answer to a pressing question or problem. This instills self-confidence in the student and reduces the burden of a one-on-one training need with the engineering supervisor.

Raw Materials: Naval Engineering Workforce Demographic

Figure 1 shows the breakdown of the Department of Defense (DoD) and Department of the Navy (DoN) engineering workforce. According to a report put out by the National Science Foundation for 2005, in the DoD there are about 93,892 Scientists and Engineers of which about 8% are involved in design processes and 14% are involved in development (NSF, 2009). Scientists and engineers were considered together in many of the role statistics due to the similar work subject matter. For evaluation purposes, the two roles are similar enough in skill set to justify such a statistical grouping in this paper. In the DoN there are 37,312 Scientists and Engineers; 7% are involved in design and 8% are involved in development (NSF, 2009). These numbers indicate that the number of scientists and engineers involved in design and development roles in DoD and DoN that would potentially benefit directly from an e-learning program is substantial. The numbers are even higher when considering the total number of scientists and engineers involved in other roles, who are also interested in learning more about the area of design engineering. This is significant because often understanding of naval design topics can enhance the capability of engineers in other roles such as project engineer, systems engineer, program manager, planning, production and research. The take away here is that there is a substantial potential audience for such a program, both in the DoN and the DoD.

The next aspect of the naval engineering demographic to consider is the distribution of the initial academic training these naval engineers have received. From a naval engineering perspective, it would be optimal if all engineers coming out of school possessed the general knowledge of ship systems of a marine engineer and the general knowledge of naval operations that a Naval Academy graduate possesses. However, the reality of the situation is that the composition of the civilian engineering workforce is a vastly different composition

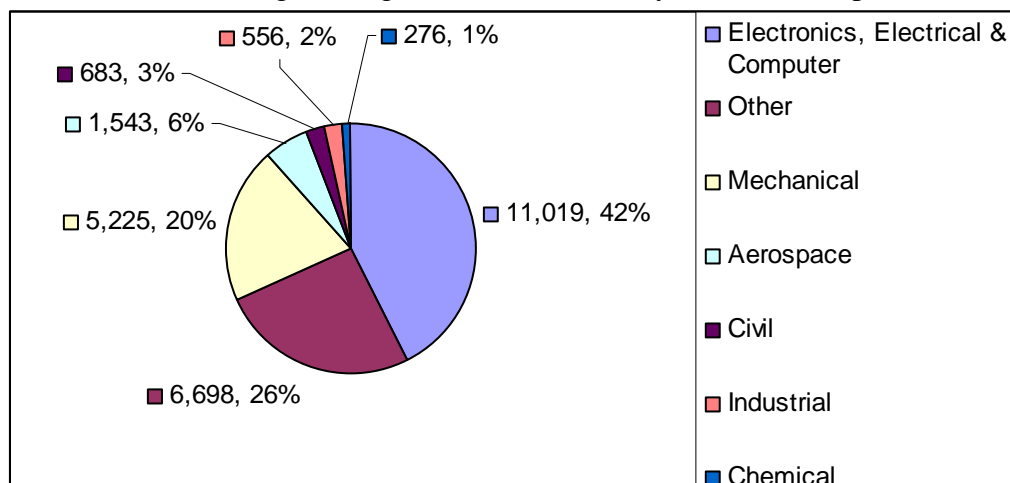


Figure 1. Distribution of Engineering disciplines in DoN (NSF, 2009)

as most are trained by private and public academic institutions with little or no specific training on naval ships and systems (Figure 1). So it becomes the responsibility of the naval activity hiring engineers from these disciplines to provide educational and on the job training opportunities that will provide the necessary knowledge during an internship to fill the desired role within the mission of the command. This is achieved with specific training in those areas directly applicable to the mission of the activity. General training about other systems and naval operations usually comes from direct experience.

Forming and Molding of an Engineer

Most Commands have Human Resources (HR) departments with workforce development programs to provide a general understanding of the equipment, policies and practices needed for successful transition from an engineer in training to the journeyman engineer level (NAVSEA, 09 November 2006). Coupled with new employee training are many different internal training opportunities, external post-graduate academic programs, and even specialized training classes tailored to a group within the command associated with a particular job assignment or mission. However, the responsibility for most of the training and the overall balance of training for each engineer generally falls to a supervisor. The first level supervisor is required to balance individual training programs and training budgets for all employees under his supervision while accomplishing his portion of the command mission. Often some of the best training comes from experiences at an even lower level human interaction through supervised on-the-job training and situational or informal (NAVSEA, 09 November 2006) mentoring from more senior engineers. Incidentally, while this is typically the default training plan for employees, it is noted that each employee is responsible for seeing that they get whatever training they need for personal success. While they cannot control funding allotments, work schedules or opportunities, they can make sure they apply for appropriate training offered by the command, be vigilant about continuing training throughout a career, and take steps personally to augment or supplement training received through their own means and on their own time if so desired.

There are several issues with this type of training that can leave gaps in the total training plan for a new engineer that might be filled by the proposed e-learning tool. The first is consistency. If a supervisor or engineering mentor delivers the basics associated with a system or piece of equipment, the quality and quantity of information transferred can vary widely. Though the job will certainly be done correctly, the extent to which an understanding about fundamental processes and procedures associated with the experience is retained by the new engineer will be a function of the teacher, student, situation and many other factors. The second factor is funding. An engineer will be fully trained before being allowed to make engineering decisions, but the rate at which this training occurs can be influenced by the budget available for training, particularly in a working capital funding environment, and whether or not it is external training. A third significant factor is scheduling, related to both the supervisor and the new engineer. Time spent on training directly with the supervisor is limited to the portion of time that supervisor has to offer each new engineer. Typically, a supervisor's available time for direct training of new engineers is proportionally weighted to the perceived greatest need, but equitable distribution of this time and other openness of discussion between supervisor and employee are other factors,

which may limit effectiveness of this training method (NAVSEA, 09 November 2006). Due to the number of employees per supervisor, often training is in the form of “Just in Time” training lessons that do not allow much leeway for application of training prior to use. In addition, a scheduling factor here is the work and leave schedule of the employee and the availability of the training opportunities being offered externally. A fourth factor that might cause a gap in the engineering training plan for an employee is the transition in work assignments caused by different customers, internal or external work transfers, and shifting supervisory or mentoring personnel. A fifth factor related to training is motivation. In a utopian environment, new engineers should be highly motivated to get all the training they can possibly handle and will take every opportunity to get this training. However, the reality is that extra training is extra work and usually goes unrewarded in the short term. Coupled with this is generally the time crunch associated with scrambling to optimize work assignments and handle flux caused by budget, policy, or schedule changes. While mandatory training seems to be frequently leveraged by continued employment, loss of privileges, or some equally undesirable consequence, there is a lot to be said for positive incentives. The most direct and obvious is a financial reward of some kind, such as a step increase in pay or bonus, which is typically the method private industry uses to reward such achievement. Yet, there are other methods of positive incentive such as offering career enhancing certifications (such as DAWIA) or increased weight given to such achievements within a command for upward opportunity or desired job assignments. A final element that can leave gaps in training is “pigeon-holing”, or working an extensive amount of time in some narrow aspect of the mission of a command. While this fills a need for the command, it creates a dilemma for the employee that fills the role because it both diminishes the opportunity for advancement due to limited breadth of experience and creates a retraining hardship on the command if the role disappears. It should also be noted that some commands and divisions have specialized, highly desired select internships and opportunities that provide a multi-faceted work opportunity all over the command, but that is the exception rather than the rule and they apply to a very small percentage of selected applicants from the total engineer population. Each of these factors has the potential to leave a gap in the overall training of a new engineer and collectively they can create a wide disparity of capability within identical segments of a workforce.

Forging and Shaping of a Design Engineer

Design engineering describes a function within most traditional engineering disciplines that blends the traditional roles of designer and engineer. A designer is typically a senior technician that has acquired experiential training in many trade disciplines, has learned a set of drafting and design skills, and has an understanding of the equipment, system, and the inter-relationship between systems. Naval designers have often gone through select advanced drafting, design and industrial process classes after having completed some apprentice training, usually with superior performance. Ideally, in the design process, a naval engineer works with the designer to form a problem solution and then uses the laws of physics and math to size its configuration to meet design requirements while minimizing factors such as cost and weight. The partnership in these roles still exists, but in an era of downsizing and role blending, the emergence of engineers being solely responsible for design decisions in a traditional industrial design environment (such as a shipyard), a project engineering role (such as a warfare center), or a management role (such as program manager or supervisor) is on the rise. The number of

opportunities for engineers to experience the design synergy of a true industrial workplace design team within the government is on the decline. However, the description of a design engineer being a blended version of these two roles does lead to a better understanding of the training needs for a naval design engineer. In order to be a successful practicing naval design engineer, an engineer must be properly trained in engineering design skills, become familiar with all aspects of the naval design process as they relate to a particular design, understand what the customer needs, understand how the whole system operates and how it relates to his product, keep pace with industry changes and have the opportunity to continually practice design engineering. Naval design engineers need to be aware of materials, drawing practices, shop practices, fabrication methods, and procurement trade-offs. A good design engineer can consider many contending designs or modifications in light of all of the above and then creatively select the best alternative to support his vision of how a problem should be solved. Apart from the skill set associated with the academic learning continuum, what should stand out from the above list is that there is a lot of information to consider and, much like the role of a systems engineer, there are a lot of inter-relationships to consider in determining an optimal set of trade-offs for a solution. Knowledge of this kind is generally acquired through in-house knowledge-sharing, training or experience. What is less obvious from this list is that the current method of acquiring this knowledge is rarely linear and progressive; instead, it is highly dependent on job assignments, available resources, sources of information, designer social networking, the working environment and many other factors. It is because of this randomness in the learning process and breadth of knowledge required that naval design engineering seems like such an ideal candidate for the parallel development of a DAU PLM style-training program.

The proposed Naval Design Engineering adaptation of the DAU training Model

Creation of a program that parallels the DAU program would likely be evolutionary from either the formation of a new group from a collection of efforts done by various Commands and agencies or an extension of a technical branch of the DAU that was groomed to grow and eventually splinter into an independent technical university. The good news about using the DAU PLM model to create a similar training method for Naval Design Engineering is that much of the training program exists and is part of existing workforce development programs. The existing training methods, classes and opportunities both in the government and outside the government provide many of the building blocks needed for such a program. The mentorship and on-the-job training experiences in place should remain an essential part of the overall training program. The three things that need to be developed are: a structured curriculum for various certification levels of naval design engineer; an internet based e-learning system that provides the wide variety of fundamental information necessary to be a more effective design engineer; and an on-line knowledge management program that provides a set of core competency knowledge and training building blocks similar to that provided by DAU for acquisition. Independent of how the program would be administered, either as an extension of the DAU or the formation of a new group, perhaps a Defense Technical University (DTU), the technical content for courses would have to be provided by the Naval technical authorities.

Establishing a curriculum for stratified levels of certification at the branch, division, Systems Command (SYSCOM), or service level is something that could be relatively easy once a properly populated set of classes is developed. Distinctions between the levels could be

achieved by varying the number of classes required, the rigor of the material being presented, and the applicability breadth of courses required similar to the 100, 200 & 300 level classes in DAU. Determination about what e-learning courses and specialized command courses would be counted towards the organization certification strata could be determined by the HR branches and supervisory engineers in the individual commands. Improved emphasis on previously defined topics could be achieved by judiciously developing new e-learning classes to parallel and support material presented in existing classroom classes. With time, such certifications should acquire the same level of inter-service recognition as the DAU credentials and perhaps act as a motivational incentive for students. The importance of the need to capture, control, and maintain required naval design engineering expertise within the Navy warrants a certification program similar to that used by DAU. Clearly, the biggest challenge in developing a Naval Engineering Design curriculum to parallel the DAU curriculum would be the creation and maintenance of a set of technical e-learning classes capable of being accessed online. However, were a class developed in a predefined format under the guidance and direction of the applicable Naval Sea Systems Command Technical Warrant Holder or Technical Authority for each currently defined technical area in the Navy, there would be an immediate equitable distribution of course development work. Once a course is developed, then periodic review and revision to update technical techniques and references should be the only maintenance required by the technical community. Table 1 shows a notional set of classes to make up a curriculum that might be suited for a design engineer working in the Combatant Craft Division of the Naval Surface Warfare Center, Carderock Division. The columns are intended to represent levels of applicability. Reference is made to Naval Ships Technical Manual (NSTM) chapters, Uniform Process Instructions, Mil-handbooks, and other collections of naval technical resources. Here the intent would of course be to identify the set of these items that would fit in a particular design engineer's Individual Development Plan (IDP). Direct benefits will include a measurable systematic means to establish the baseline naval technical competence of employees and technical health of an organization. The information could be passed to an activity whose mission was more in the e-learning area to make changes to the instructional module and integrate them into an accessible web site. The use of e-learning for actual academic training in the classrooms is already part of many engineering curriculums (Ubrell, 2000). Engineering materials used in actual engineering classes are available free online from several institutions, including Massachusetts Institute of Technology (MIT). As an interesting side note, the mechanical engineering department on the MIT site has several classes in hydrodynamics and marine engineering related topics. The point here is that students will be leaving the academic experience with an exposure to e-learning and should take to the technique readily.

The second challenge towards implementation of this type of program is to find and fund a host activity. The good news is that there are many web-based hosting networks. However, in the government, one of the problems with such an effort is to strike a balance with Information Technology (IT) security that has an acceptable balance of value to risk for naval leaders. Some existing e-learning networks are Enterprise Safety Applications Management System (ESAMS), Navy Knowledge Online (NKO), Defense Acquisition University (DAU), and the Office of Personnel Management's e-learning center. There are also proven design engineering web-based learning systems such as Sharefast (Kazuo Heikata, 2007) that highlight learning engineering design by workflow. Investigation into a partnership with an existing host or using the model of an existing host to form a new online network would need to be accomplished. Given the

existence of both similar parallel programs and applicable training classes, one could argue that this proposal is already at the third developmental stage. To ensure success, a design engineering variation of the DAU model would need to either be stood up as a new organization dedicated to storage, transfer and management of technological knowledge related to design engineering such as the DTU, or expanded within the mission scope of an existing organization such as DAU to include technological knowledge until it was large enough to be its own program. Either way it is a process that will take some time. The funding for the organization of such an effort at the DoD level should come in the form of a separate line item in the DoD Congressional budget so as not to influence existing training efforts. The costs for professional course development are dependent on the type of class that is desired. Defelice & Kapp have prepared a table showing the number of man-hours that go into one hour of particular training. The range of time expected for professionals to prepare stand-up training classes was 43-185 hours per hour of classroom instruction (Kapp). The range of time expected for professionals to prepare classes similar to DAU with interactivity and varying degrees of animations was 49-365 hours per hour of instruction (Kapp). When considering the number of technology areas worthy of instruction, this cost number is staggering. However, there is utility to be gained in the short-term by developing classes in house to the extent resources and capabilities exist. At the low end, an e-learning class could be made from a MS-PowerPoint presentation on a subject that was converted to a web-friendly form using specialized software such as Flash. Although probably not as effective or of quality comparable to that of a professional quality e-learning course, a product made in house could be made more effective to the extent pictures, graphics, videos, and animations (and software to edit them!) are at the disposal of the technical activity preparing the training. If the format required for all classes was defined by DoD, then technical activities unable to fund professionals could submit their versions of training classes to a repository for use until it was determined that the cost for professional preparation was warranted. Therefore, finding an activity to assist with hosting naval design engineering classes and developing courses is possible but will require training budget funding support.

The final of the three elements needed for successful implementation of a naval design engineer training program is a knowledge management system. DAU has provided knowledge management that is tied directly to training elements and therefore information disseminated in training modules can easily be traced back to source documents. Traceability of a design decision to a performance requirement or similar technical guidance document is important in collaborative discussions about balancing tradeoffs in a design. However, as designs become complex and costly, these discussions frequently occur relative to attempts made by group members outside the design decision process to reduce some overall characteristic such as weight or cost, often some period after the decision. Another challenge for naval engineering design management is to stay aware of changes in design guidance policy through the duration of a design. Contracts between design engineers and customers, production facilities, and equipment providers frequently evolve during the duration of a project with changing circumstances, internal or external guidance, scheduling or funding influences. The trickle-down effect of such changes needs to make it to the people that understand the impact quickly enough to enable timely reaction. Design engineers also must keep abreast of industry developments, products and methods that can be used for a more efficient design. Budget pressure, time constraints, and risk avoidance too often cause designs to rely on what was done previously without due consideration for what might be gained by using new materials, methods or

concepts. Access to information quickly from a knowledge management program can reduce the time spent and therefore cost of investigating potential design improvements. Although the previous version of a successful design should usually be considered as the contender for a design evolution, the security in the knowledge that it worked before too often leads to lack of energy spent pushing the design envelope. Convincing approving authorities of the value of new features relative to the implied risk of any new design is much more likely to succeed with substantiating test data, procurement histories and customer feedback as supporting arguments. When multiple things are changed simultaneously in a design, the complexity of supplying supporting evidence to decision makers in a risk to benefit analysis would be greatly enhanced by the ability to easily extract design data from other successful applications of the individual parts or processes from prior applications, testing and research data. A good engineering knowledge management system would provide the new design engineer with an easy method to reach the combined historical engineering expertise of many other engineers and products to support design decisions. A good engineering knowledge management system should also enable senior engineers a method to enter the findings and results of their designs to assist future design engineers.

Conclusion

The development of a technical e-training and knowledge management program as a training tool for naval design engineers such as the DTU or a technical extension of the DAU program for acquisition training is a proposal that has the potential to improve the design engineering capability in the Navy. A set of on-line classes as proposed will add a fluid systematic training tool into the arsenal of first line engineering supervisors that can be seamlessly integrated with existing programs and fill many of the gaps in existing training. Properly prepared course modules will provide a resource that reinforces baseline technical competence for employees engaged in engineering design or engineering design related job functions. The curriculum would serve as a baseline tool for supervisors to transition technical personnel from the academic world to the real world of naval design with fundamental instruction and guidance. The vision is to have a set of classes from which the supervisor and employee would select courses when developing the IDPs that match the employees' job description, level of expertise, and career interests.

This program could serve as an example and precedent for extrapolating similar design engineering programs in other commands and activities. Courses developed for more general material and knowledge applicable to all commands within a SYSCOM, DoN, or DoD could be part of the list of choices selected by employees or supervisors. The need for the government to be able to grow design engineering talent internally cannot be overstated. Senior engineers with engineering design vision that are capable of providing technical leadership and guidance in solving highly complex problems or developing complex systems need to be retained and encouraged to find ways to inspire talent in new generations of design engineers entering the government. Providing a set of training tools for increased breadth of understanding about specific systems, procedures, and equipment of a technical nature maintained in a DTU will enable naval design engineers to achieve a structured learning program that can be tailored for the individual. Including knowledge management tools such as are employed by DAU will also provide senior design engineers a means of passing lessons learned and design knowledge to the

Table 1 Notional Curriculum of E-learning Courses in a Naval Design Engineering Discipline

Code/Branch Level	Division Level	SYSKOM Level	DoN Level	DoD Level
Boat Piping	Drawing Preparation Process	NAVSEA STD Chapters	DAWIA Training	Corrosion
Boat Engines	Material Selection & Support	Shock Approval Process	Standard Drawings (Use, upkeep, indexing)	Reliability, Supportability, Availability, Survivability Design Trade-offs
Boat Power transmission	Welding & Joining	Vibrations Issues & Concerns	Mil-Hdbks, Specs, Manuals, Instructions (use, indexing, locations)	Personal Responsibility & Work ethic. Effectiveness, defeating obstacles, work-a-rounds, rules, help
Boat Motion	Fasteners	Environmental issues & testing	Ship Building Process	Accountability for Work & Money
Boat Electrical Systems	Proposal Process	Industrial processes (UIPIs, AIM, I&V,)	Ship Maintaining Process	Security related issues
Boat Structure	Q/A Process	Program Management techniques and support	Ship Modernization Process	Effective Writing (Might be a good Blog format)
Basic Naval Architecture of Boats	BoatAlt Process	Logistics Support related to Ships (NSNs, APLS. Tech manuals, COSAL, Resources	Naval Assets-Mission ,Needs, interaction- Ships, Commands, Facilities, and Labs	Improved Communication (Covey, Dale Carnegie. Etc.) that could be web based w/follow-on class
Arrangements & Integration of Boat systems	Inter-code, Inter-activity, and Contractor work tasking processes	Special Programs Requirements (SUBSAFE, HAZMAT, RADCON, ALRE, Levelized Material)	Budgeting & Funding-POM cycle, Congressional Plus-ups, Alts, AR, AER, Service Change, MACALT, ECPS	Beneficial Suggestions, Lean, & Process refinements –Pro-Active mind-set, Constructive criticism techniques, administrative & managerial empathy
Procurement process	Project Management	Weight & Stability	Correspondence Formats	Computer Skills (MS-Project, Word, Excel, Outlook) Int & Advanced levels
Analytical requirements documentation, FEA, & Techniques	Customer Awareness & Customer Advocate Roles	SYSKOM Admin Processes- ECPs, FMP, R&D projects, Collaborations with ONR, DARPA, NASA, etc.	General Naval & Marine Engineering (Systems, nomenclature, arrangements, DC, Safety, crew)	External Professional opportunities – Design Competitions, Mentoring, College collaborations, Links, & Forums
IDP Primer, Examples and Recommendations	Division Career Management, Goals, & Opportunities	SYSKOM Career Management, Goals, Methods and Opportunities	DON Career Management, Goals, Methods and Opportunities	Inter-Agency Career Management, Goals, Methods and Opportunities
Code Resources (Computer, Library, Lessons learned, Applicable design specs, Prior work, SMEs)	Division Resources (Computer Resources, Library, Tests, Lessons learned, Parallel efforts)	SYSKOM Resources (Computer Programs, Reports, Library, Tests)	DON Resources (Computer Programs, Databases, Library)	DOD Resources-Computer Programs, Library, Databases, Agency related topics, High-Tech Partnerships, NASA, DARPA, ONR, Industry

next generation in a systematic way, thus preserving the naval design engineering human capital for the government.

The potential for design related cost effectiveness dividends and systematic innovation from the aggregate naval design engineering human capital asset, when fitted with a well tuned e-learning and knowledge management tool, is a very attractive prize. Engineering supervisors with this training tool at their disposal could integrate its use into IDPs with the employee to work together to find the most cost effective mix of career path training methods for mission support. Web-based training is a training method that is growing in popularity worldwide and already present in many engineering academic institutions. The low relative cost, flexibility in scheduling, and ease of access are attractive sales points. However, web-based training alone is not as effective as when it is used with other methods, particularly when part of the transitioning goal is the ability to successfully apply lessons learned. When e-learning methods are used together with focused classroom instruction, on the job training, and supervised experience, there is a synergy that produces a very effective educational experience. These tools are presently used successfully by the DAU to provide training in complex subject areas in the acquisition process and the door is open to provide a similar parallel system to the technical community.

Empowering employees with a fluid means of getting directly applicable training via the internet will improve employee general performance and shift some of the burden of training from the first line supervisors. It will also provide a cost effective and standardized systematic approach to technical areas capable of influencing design or design related activities.

Recommendations

1. Technical activities should consider creating technical training modules to train new personnel in subject matter cognizant to that activity. Training modules should be developed such that they could be used by the widest possible DoD audience to maximize potential utility and return on investment.
2. DoD should create a Defense Technical University that parallels the DAU and employs a program similar to DAU's PLM to train new design engineers, capture the existing design engineering human capital resource, and provide a means of knowledge management for naval design engineers. This new program should leverage to the greatest extent possible the grass roots e-training efforts by technical activities and be the path of least resistance when it comes to getting quality naval design engineering information.

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